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Students' questions in Higher Education chemistry classes according to their gender

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Abstract

Considering the relevance of student questioning in the teaching, learning and assessment processes, this research proposal was developed, to investigate and characterize feminine and masculine students' questioning profiles, in higher education, in different situations, such as traditional classes and online interactions. It is our intention to conceive and implement strategies to promote student questioning in the different environments provided by the subject (classes and online interactions), according to the specificity of each gender, in order to contribute to the optimization of the teaching, learning and assessment processes, in higher education. The project is being developed within first year chemistry classes, at the University of Aveiro, following a mixed (qualitative and quantitative) methodology. Data is being collected through observation, interviews, focus-groups, one inventory and by means of an online forum.

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1. Introduction

This study is aimed at contributing to a better understanding of student questioning in the teaching, learning and assessment processes in higher education, focusing on the gender gap. The study is being conducted with first year chemistry students, at the University of Aveiro, in Portugal. It is our intention to investigate and characterize feminine and masculine students' questioning profiles, in different situations, such as traditional classes and online interactions and to conceive and implement strategies that foster student questioning and create a welcoming setting for the raise of questions by students of both genders. We thus look forward to contribute to greater gender equity in the learning, teaching and assessment processes, in particular in higher education chemistry classes.

2. Review of the literature: questioning

Research on science education sustains the need for new emphasis on teaching and learning, particularly in higher education. Among the essential skills that every higher education student should achieve, emerges the most significant indicator of the highest and most critical level of students reasoning - the questioning skill (Almeida, Teixeira-Dias & Martinho, 2010; Pedrosa de Jesus, Teixeira-Dias & Watts, 2003; Zoller, 1987). Hofstein, Navon,

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Kipnis & Mamlok-Naaman (2005) support that a teaching practice oriented to the development of such skill favors a learner-centered teaching and learning and promotes higher cognitive level capacities, such as those of critical analysis and problem resolution.

Several studies (Pedrosa de Jesus, Almeida, Teixeira-Dias & Watts, 2007; Chin & Osborne, 2008; Hofstein *et al*, 2005) have revealed that fostering a true questioning spirit of students can result in an improvement on the quality of teaching and, accordingly, on the quality of learning. For this reason, the Boyer Commission's report (Boyer Commission on Education Undergraduates in the Research University, 1998) highlights the importance of promoting the questioning skill from the first year of university studies. Furthermore, universities need to offer students a first year wherein their learning experiences assure the development of the necessary skills, such as that of questioning, to empower them for lifelong learning (Johnston, 2010).

In light of the numerous advantageous features of network technology, there has been a growing number of projects focused on the design and development of web-based student question-generation learning systems (Yu, 2011), many of which in higher education.

Results provided by Barak and Rafaeli (2004) sustain that web-based activities, which require student generated questions, can serve as both learning and assessment enhancers in higher education by promoting active learning, constructive criticism and knowledge sharing. On his turn, Wilson (2004) highlights that when students write exam questions and evaluate other students' responses they improve their ability to communicate and integrate facts, their critical thinking skills and their motivation to do additional readings. Similarly, Yu, Liu & Chan (2005) remarked the importance of fostering student questioning through online multimedia tools and noticed that by enabling students to compose questions, criticize and adapt other students' questions, they perceived their learning as more motivating and cognitively-enhanced.

Concerning student questioning, few studies have focused on gender and even fewer have concentrated on gender differences on higher education. However, Wood (2009) states that although women perform better at every levels of education and earn more and higher degrees than males do, women still face biases and barriers in particular fields, namely math and sciences.

Despite the recognition of the existence of gender differences in verbal communication for a long time (Wood, 2009; Tannen, 1990), the few existing studies are not consensual. On one hand Pearson, West & Turner (1995) stated that it is not clear which gender raises more questions. On the other hand, Jones, Howe &Rua (2000) observed that boys are less frightened than girls to pose questions. Blum (1999) undertook an investigation to compare the questioning patters of boys and girls, either in class or online, and concluded that girls ask more questions than boys in class, while boys ask and answer more than girls in online environments.

Facing such a controversial issue and considering the great importance of students' questions in the processes of knowledge construction, it is important to investigate and characterize students' questioning profiles according to their gender and to the learning environment in which they are immerse (such as classes or online environments).

3. Aims, objectives and research questions

The purpose of this study is to contribute to a better understanding of student questioning in university education, focusing on gender differences, as well as in the design and implementation of strategies to make university education in chemistry more equitable, taking into account the specificities of the genre.

This study comes in the wake of other projects focused on questioning of students of the University year 1, developed in the Research Centre for Didactics and Technology in Teacher Education, at the University of Aveiro, in Portugal (Almeida, 2007; Moreira, 2006; Pedrosa de Jesus *et al*, 2003; Souza, 2006; Teixeira-Dias, Pedrosa de Jesus, Neri de Souza & Watts, 2005).

The option of carrying out this study with students of chemistry deals with the recognized impact and centrality that this discipline currently has. Chemistry provides a contextualized learning in everyday situations, encouraging interaction, discussion and debate between teacher and students (Teixeira-Dias, Pedrosa de Jesus, Souza, Almeida & Moreira 2009).

Thus, the objectives of this project are to:

1. identify and characterize the questioning profiles (number and type of questions) of boys and girls in the learning of Chemistry in the 1st year of university, in different contexts (face-to-face and online environments);
2. identify and characterize the approaches to learning of boys and girls in the learning of Chemistry in the 1st year of university education;
3. identify the conceptions of boys and girls about the role of questioning in the teaching, learning and assessment processes;
4. identify and characterize relationships between the questioning profile of students (boys and girls) and its role in the process of constructing knowledge (teaching, learning and assessment processes);
5. examine the relationship between the questioning profiles of boys and girls and the grades obtained by these in the chemistry course;
6. conceive, produce, implement and evaluate teaching, learning and assessment strategies aimed at promoting student questioning, and optimizing the learning of boys and girls, in higher education;
7. analyze the implications of the teaching, learning and assessment strategies aiming to promote questioning in the approaches to learning of students of both genders.

The research questions presented below are based on a thorough and critical review of national and international literature and are related to the aims described above.

The main research questions of this project are:

1. What are the differences between feminine and masculine students' questioning profiles in first year university chemistry classes?
2. Which strategies and teaching practices can promote student questioning, attending to their gender, in order to optimize chemistry learning in university teaching?

There are a series of sub-research questions that can be addressed:

1. How are the feminine and the masculine understandings of the role of questioning in the teaching, learning and assessment processes affecting their questioning profiles?
2. What influence do different learning environments (such as traditional classes and online interactions) have on feminine and masculine students' questioning profiles?
3. How does implementing strategies to foster student questioning reflects on the learning approaches of feminine and masculine students?
4. To what extent are the students' grades (feminine and masculine) influenced by their questioning profiles?

With the purpose of finding answers to these research questions, the present study aims to contribute to the quality of university education through the design of strategies that can be implemented in other contexts (different courses, different disciplinary fields).

4. Research design and methods

This study follows a naturalistic ethnographic approach and the methodology is mixed (qualitative and quantitative). Several techniques are being applied, such as one inventory, observation and documentary analysis. The corresponding developed instruments are semi-structured interview scripts, focus groups scripts, observation grids for classes and for online interactions, audio and video records and the researcher's diary. An inventory aiming to identify students' learning approaches will also be applied (Tait, Entwistle & McCune, 1998). This inventory has already been developed, translated and validated to the Portuguese context (Approaches and Study Skills Inventory for Students - ASSIST; Valadas, Gonçalves & Faísca, 2010).

The focus groups, the records of the online interactions, the researcher's diary and the interviews made to students and to teachers will be qualitatively analyzed (content analysis). On the other hand, the observation grids, the inventory and the classification grids will be statistically analyzed.

The first stage of this investigation, accomplished between March and September 2011, consisted in a critical literature review to understand what had already been studied regarding female and male students questioning and in

the preparation of the data collection instruments. At the same time, strategies were developed to foster student questioning and create a welcoming setting for the raise of questions by students of both genders, either to be applied in class or through the online platform that supports the curricular unit, the Moodle.

Following this initial stage we proceeded to the pilot-study, which was carried out during the first semester of the academic year 2011/12. The pilot-study served as a testing study of the previously conceived techniques, instruments and learning, teaching and assessment strategies.

The empirical data for this study was mainly gathered through a non-participant observation, audio recorded classes, administration of an inventory and records of online interactions.

The students observed were first year undergraduate students of science and technologies degrees, who attended two chemistry courses. The total number of students in the first semester was approximately 160. Following data treatment and analysis, and having in mind the lecturer's perspective, the necessary improvements are being made before the main study to be carried through the second semester of 2011/12.

During the main study besides class observation, analysis of online interactions, application of one inventory and implementation of learning, teaching and assessment strategies, focus groups will be conducted with students and interviews will be made to students. Furthermore, during this second semester we will proceed with the sessions of debates and shared reflections with the class's Chemistry teacher. At the end of this main study we will treat and analyze the collected data.

The final part of this study will be dedicated to an integrated analysis of the results retrieved during the pilot and the main study, and to the writing and presentation of the PhD thesis.

Throughout the timeframe of this project a deeper critical scientific backup will be made through further readings and review of specific literature.

5. Preliminary findings

Although the global results are not yet available for discussion, there are some findings that have already emerged from the pilot-study, such as: a) only a small number of oral questions were formulated either by male or female students during lectures; b) even a smaller number of students' questions were written in the pieces of paper provided to students in class and collected after the end of each class, c) a significant number of the questions formulated in class evolved into an interaction episode between the student and the teacher, d) males pose more questions in class than girls, and e) by the end of the semester students pose more questions online than during the beginning or middle of the semester, but those questions are mainly referring to the evaluation procedures rather than Chemistry content.

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